A QUASI-CONTAINERLESS PENDANT DROP METHOD FOR SURFACE TENSION MEASUREMENTS OF MOLTEN METALS AND ALLOYS

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A knowledge of the surface tension of metals and alloys is essential to an understanding of metallurgical processes and low-gravity processing schemes involving a free surface, such as floating-zone crystal growth, and to confirm molecular theories of molten metal surfaces. Most standard ground-based techniques for measuring molten metal surface tension involve contact of the molten metal with a foreign support material that often contaminates the surface and causes large errors in the measurement.

A quasi-containerless pendant drop method for measuring the surface tension of molten metals and alloys is being developed. The technique involves melting the end of a high-purity metal rod to form a pendant drop by bombardment with an electron beam under ultra-high vacuum conditions. The drop shape is subsequently analyzed using digital image analysis to calculate the surface tension. A computer program has been developed that reads the pixel intensities from a graphics file containing the digitized image. The code searches for the edge of the drop along each row or column of pixels and stores the edge coordinates in an array. It then computes a trial theoretical drop shape by solving the Young-Laplace differential equation from which the quantity of surface tension is deduced. The full-shape analysis described here has several advantages over the standard selected-plane analysis that uses only two diameter measurements to calculate surface tension. The full-shape analysis generally gives a lower standard deviation than the selected-plane method. Furthermore, if the theoretical and experimental shapes fail to match closely after optimization, this can indicate nonuniformities in the surface tension arising from temperature gradients or nonuniform impurity distributions along the surface.

The novel aspect of this technique is that the pendant drop of molten metal is in contact only with its own solid and any initial surface contamination can be evaporated away by prolonged heating of the sample near its melting point. This is expected to produce a surface purity comparable to what can be achieved by the low-gravity containerless method in space, The pendant drop method has the added advantage that it is a static method, thus presenting less uncertainty in the interpretation of results than with a dynamic method. A detailed description of the technique and preliminary test results will be presented at the meeting.